

UWB Band Pass Filter with WLAN notch

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Abstract — In this paper, UWB technology operating in broad frequency range of 3.1-10.6 GHz has shown great achievement for high-speed wireless communications. To satisfy the UWB system requirements, a band pass filter with a broad pass band width, low insertion loss, and high stop-band suppression. UWB band-pass filter (BPF) with wireless local area network (WLAN) notch at 5.8 GHz and 3-dB fractional bandwidth of 108% using a microstrip structure is presented. Initially a two transmission pole UWB band pass filter in the frequency range 3.1-10.6 GHz is achieved by design a parallel-coupled microstrip line with defective ground plane structure using GML 1000 substrate with specification: dielectric constant 3.2 and thickness 0.762 mm at centre frequency 6.85 GHz. In this structure a $\pi/4$ open circuited stub is introduced to achieve the notch at 5.8 GHz to avoid the interference with WLAN frequency which lies in the desired UWB band. The design structure was simulated on electromagnetic circuit simulation software and fabricated by microwave integrated circuit technique. The measured VNA results show the close agreement with simulated results.

Index Terms — UWB (ultra wide band), BPF (band pass filter), PCML (parallel coupled microstrip line), WLAN (wireless local area network), MIC (microwave integrated circuit), SIR (step impedance resonator), DGS (defective ground structure)

I. INTRODUCTION

The ultra-wide band (UWB) frequency spectrum (3.1 to 10.6 GHz) was released in 2002 [1] by FCC of the United State for unlicensed indoor and hand-held commercial applications shown in the Fig. 1. Because of the attractive merits such as high mobility, flexibility and extremely high data-rate etc, the UWB radio systems have been raising more and more attention from scientists and engineers. For some practical applications, there is a need to introduce notch band (s) with in the UWB pass band to avoid the interference from existing wireless communication systems such as band 3.5 GHz WiMax and 5.6 GHz band wireless local area network (WLAN). In recent years many techniques such as embedded open circuited stubs, Multilayer LCP etc. have been proposed for design the UWB band pass filter [1-5].

It feature single notch with rejection and a wide stop-band, implementation with relatively small circuit. The notch can be tuned and designed by adjusting the dimensions of SCRLH resonators[2-3]. The BPF feature at 3-dB pass-band from 3.0 to 10.7 GHz, with the single notch band extending from 5.9 GHz. a novel UWB BPF with single notch band using aperture backed parallel-coupled microstrip line by embedding an open circuited stub in the 50 Ω feed line were proposed[4-5]. The features of the scheme in comparison with proposed in literature are simple design, compact size,

low loss and good linearity in the UWB, and easy integration with other circuits and antennas. In the section II The design of the proposed filter is presented. In the section III characterization of notch filter is discussed. In section IV, the fabrication and experimental results are expressed. Finally paper is concluded in the section V.

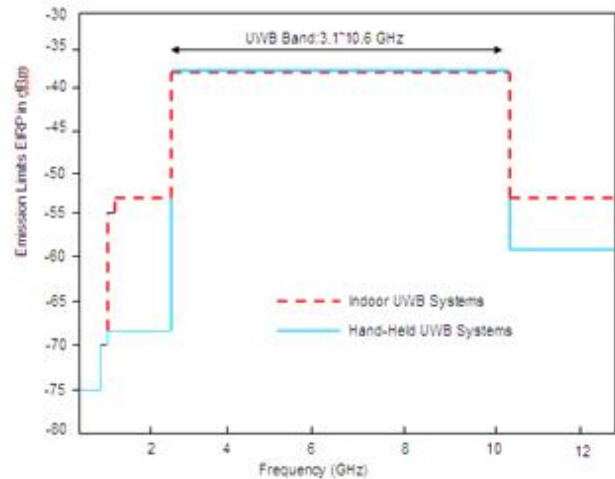
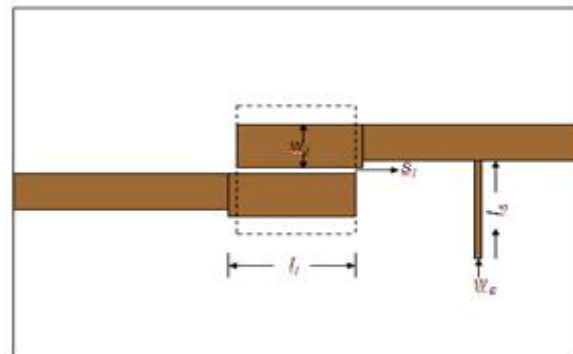


Figure 1 Emission limits of EIRP for indoor and hand-held UWB system

II. UWB BPF DESIGN WITH NOTCH

The layout of the proposed UWB filter is mentioned in the Fig. 2. It comprises an aperture backed parallel-coupled microstrip line. It is connected by a 50 Ω microstrip line at the two sides. The rectangular shaped aperture in the ground plane is placed below PCML to tighten the coupling between the lines[7-8]



(a)

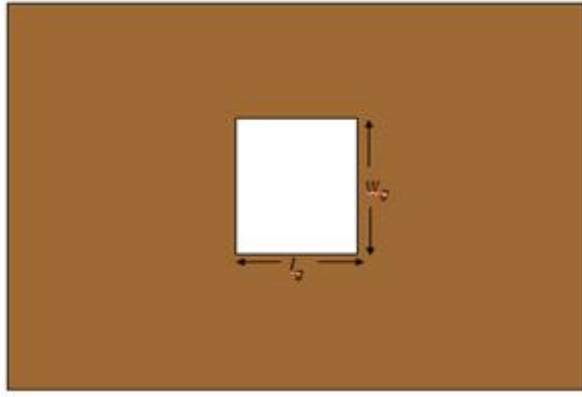


Figure. 2 Structure of parallel-coupled line UWB notch filter (a) Front view (b) Back view

An approximately $\lambda/4$ open circuited stub is embedded in the appropriate place of the $50\ \Omega$ feed line. The structure shown in the Fig 2 is optimized by simulating it on EM simulator. The simulated frequency response of the UWB band pass filter with notch is shown in the Fig 3.

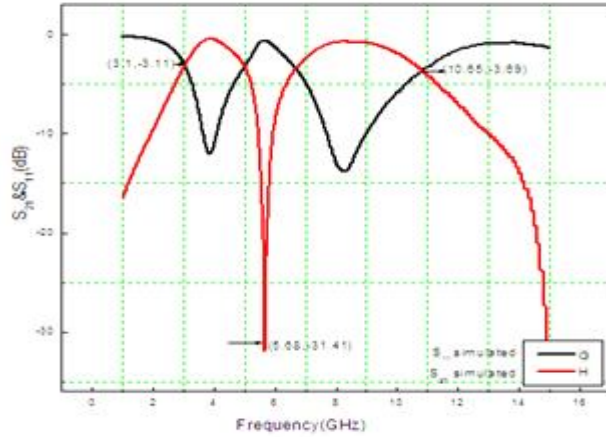


Figure.3 Simulated frequency response of single parallel-coupled line UWB notch filter.

III. CHARACTERAZATION OF NOTCH UWB FILTER

In the UWB band pass filter, a open circuited stub is incorporated for designing a notch at the desired frequency. The variation in length and width of this stub affect the notch frequency and the insertion loss $|S_{21}|$. It is observed that decreasing the stub length the notch frequency increases with slight variation in the value of insertion loss S_{21} , while notch frequency shifted towards lower side on increasing the stub length,[8] which is shown in the Fig.4. A microstrip DGS has a periodic etched defect on the ground plane and can deliver good stop –band charactertics in high frequency microstrip circuits. An DGS is comprised of two semi circular defected area and one narrow conducting slot on the ground plane.

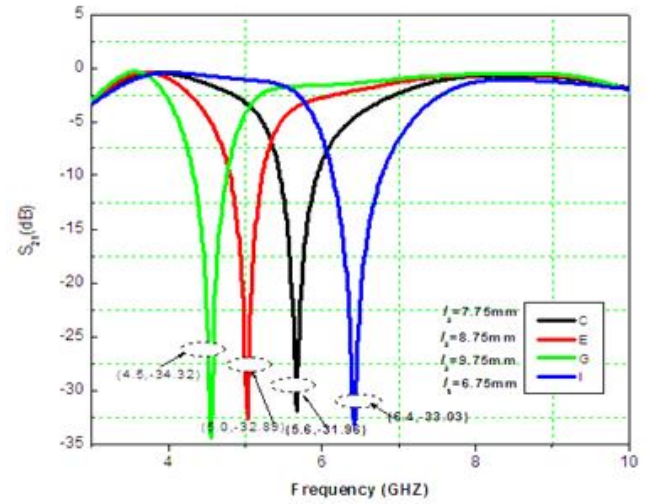


Figure 4.Effect of the variation in the stub length on the notch frequency

IV. FABRICATION AND EXPERIMENTAL RESULTS

Based on the proposed design the UWB notch filter can be achieved by an aperture backed PCML with open circuited stub in the feed line. The optimized parameters of the UWB notch filter is shown in the Table 1

TABLE. I. DESIGN PARAMETER OF UWB NOTCH FILTER USING SINGLE PCML

l_1	w_1	s_1	l_g	w_g	l_s	w_s
6.8	1.85	0.11	6.75	6.01	7.75	0.3

l_1, w_1, s_1 are length, width and spacing between the PCML

l_g, w_g are the length and width of DGS.

l_s, w_s are length and width of the stub.(all dimensions are in mm)

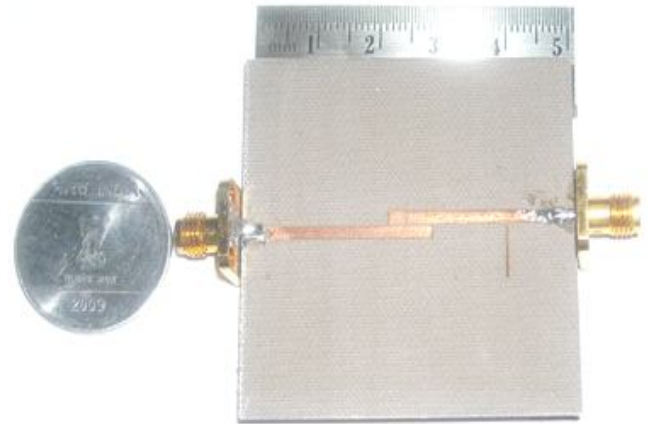


Figure.5 Front view of fabricated structure

In Fig.6,the comparison between the simulated frequency response and measured frequency response is displayed.

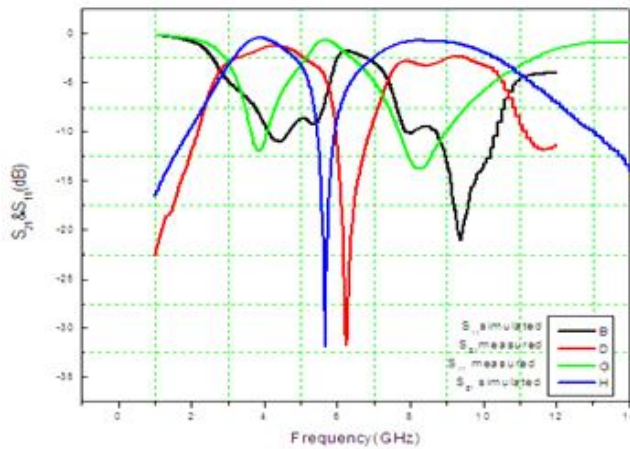


Figure.6 Comparison of responses of UWB notch band pass filter

From the comparison of results we can make some conclusions as follows: (1) the measured frequency responses agree well with the predicted results in the whole pass band, stopband and notch band which validates the proposed design theory. (2). The return loss $|S_{11}|$ is 1.0 dB at the frequency 6.85 GHz. (3). The insertion loss $|S_{21}|$ of the magnitude -30 dB values is verified with the simulated results but the frequency of the notch is slightly shifted towards high frequency side.

V. CONCLUSIONS

A compact UWB BPF with notch filter has been presented. Initially a UWB band pass filter has been achieved by an aperture backed PCML. The desired notch (rejection) band is introduced by an open circuited stub in the 50 Ω feed line. The notched band can be controlled by properly selection of the location of the stub, width of the stub and length of the stub. A filter with a WLAN notch band is designed, simulated and fabricated. The measured results show close agreement with the simulated results which validates the proposed filter design theory. The proposed UWB notch filter are promising for the application in new UWB wireless technologies due to its simple structure, the proposed antenna provides good performance over single wireless band showing true single band characteristics, low insertion loss, broad pass band width and high stop band suppression, compact size, and easy integration with antennas and other devices [12-13] The proposed antenna are used WLAN and WiMax applications.

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